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Nutrient dynamics in fen peat in relation to water level management: a mesocosm experiment

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Peatlands are valuable ecosystems that hold a high biodiversity and provide many ecosystem services such as carbon sequestration, water storage and water purification. However, a large part of the peatlands are drained, often for agricultural purposes, resulting in CO_2 emissions, soil subsidence and biodiversity loss. To combat these negative effects, various rewetting measures are being installed which can be combined with varying land-uses such as intensive dairy farming, extensive agriculture, semi-natural grasslands, paludiculture (farming on moist/wet soils) and nature restoration. This broad applicability implies that the extent by which the groundwater level is raised can be fine-tuned to the intended land use. In our study, we conducted a mesocosm experiment in which we exposed intact fen peat cores (80cm, 20cm Ø) to five different water levels (0, 20, 40, 60 cm and variable - surface), two nutrient application levels and two water qualities. For an eight-month period, monthly samples from each peat core were taken at two depths and chemically analyzed. Further, the vegetation in the cores was cut five times throughout the growing season. Above-ground biomass was measured as well as nutrient concentrations in the vegetation. Our results show increased phosphate and ammonium availability upon fully rewetting (0 cm – surface), in contrast to partially rewetted circumstances (20cm – surface) where nutrient availability was lowest. Above-ground biomass was strongly affected by nutrient application and, except for early spring growth, less by water levels. Nitrogen concentrations in the vegetation decreased with increasing water levels indicating stronger nitrogen limitation. This is likely the result of increased denitrification rates under wet circumstances. We conclude that in order to achieve nature restoration under fully rewetted conditions, additional steps must be taken to remove nutrients, particularly phosphorus, from the system. Further, we conclude that partial rewetting can be a solution to slow down the adverse effects of drainage, although agricultural production will decrease.